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REPORT ON IRRIGATION

IN THE

DUNGARPUR
STATE,

WITH

NOTE BY THE CONSULTING ENGINEER FOR IRRIGATION
IN RAJPUTANA.

1904.

AJMER :
SCOTTISH MISSION INDUSTRIES CO., LTD

1904.

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Map of Dungarpur State 4" = 1 Mile.

REPORT ON IRRIGATION IN THE DUNGARPUR STATE.

The Dungarpur State is separated on the north from Udaipur by the Som River; on the east by the Mahi River from Banswara; and on the south and west it is bounded by the Rewa and Mahi Kantha Agencies of Gujarat.

Geographical
Position.

2. Its length from east to west is 40 miles; and its breadth from north to south 35 miles; and it has a total area of about 1,400 square miles. Except for a few square miles on the east, the country is a hilly tract, a network of hills and valleys.

Area

3. The chief rivers are the Som and the Mahi on the north and east borders, which join at Baneshwar in the north-east corner of the State.

Rivers.

(a) The Gangri Nullah, which is joined by the Sapin about 3 miles north-west of Dungarpur Town, flows into the Som, and these two, with their tributaries, drain the north-west corner of the State.

(b) On the east border the Mahi is joined first by the Pojpur Nullah, which drains the north-east corner; then lower down by the Moran, which, with its tributaries the Sandri and Bhai, drains the central portion; and further south by the Bader Nullah, which drains the south-East.

(c) On the west of the State the drainage is carried away by the Vatrak and Majam Nullahs.

4. The average rainfall for the last ten years is 25 inches.

Average
Rainfall.

The following table of the rainfall for the last seven years shows how the rainfall has varied :—

Years.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
Rainfall in inches ...	17.78	10.29	28.62	12.89	35.65	33.80	16.16

5. The population returned by the Census of 1891 was 165,400, of whom 66,951 were Bhils. In the 1901 Census the figures were reduced to 100,103, of which 33,887 were Bhils.

Popu-
lation.

This reduction was due to the Famine; and to show how severely the Bhils were affected, it will be noticed that the reduction in the Bhil population is 49 per cent. as compared with $3\frac{1}{2}$ per cent. for the remainder.

Villages
and Land
Revenue.

6. There are 720 villages of which—

215 are Khalsa.

32 Joint (Khalsa and Jagir.)

473 Jagir and Muafi.

720

The Revenue Settlement is now in progress, but at present the average area of land under cultivation annually is not known.

The land revenue is about Rs. 86,000 Imperial, and the revenue system at present consists of a fixed village cash assessment irrespective of the land or area cultivated, for the payment of which the headman of the village is responsible.

Every alternate year an additional Revenue of about 50 per cent. in the Kharif crops is collected, the average of which amounts to about Rs. 10,000 (Imperial).

Means of
Irrigation
Wells.

7. Irrigation is carried on from Tanks, from Wells, and from Odis on the Nullah banks.

There are about 2,500 wells in the State, of which 800 are in disuse for want of repairs; but Takavi advances, amounting to about Rs. 7,000 have been sanctioned, and are now being given to deepen and improve 105 of these, scattered about the State one per village.

The average cost of a masonry well is Rs. 500, and that of a "kutchra" well Rs. 150; a well irrigates about 4 bighas.

Tanks.

8. The following is the number of tanks in the State :—

In use	...	...	...	...	...	206
Breached and out of repairs	...	...	...	...	...	134
						<u>340</u>

In the report for the Dungarpur State submitted by the Assistant Resident, Mewar, and laid before the Irrigation Commission in 1901, only 10 tanks of those in use were said to be of real value for Irrigation; and of those in disuse the repair of the nine noted below was recommended, as it was thought that these too were the only ones likely to be of use for Irrigation :—

No.	Name of Tank	Catchment area—square miles.
1	Wagdari	2½ Square miles.
2	Ranpur	2½ "
3	Nolsam	6 "
4	Sondawara	7½ "
5	Genji	7 "
6	Wasi	3 "
7	Pachlasi	2 "
8	Pojpur	22 "
9	Kolkanda	¾ "

9. The rains of 1901 failed in Dungarpur, and Relief Works had to be opened ; and in December of that year I visited the State to assist in starting these, and inspected several of the tanks in disuse, giving sketch plans and written directions for the work required on each ; and as distress increased and new works were required, a second visit was made in February 1902.

**Tanks
repaired
on Relief
Works in
1901.**

Eventually work was carried out on 19 of the tanks in disrepair, including the six larger ones of Wagdari, Rampur, Nolsam, Sondawara, Genji, and Kolkanda ; and at Wasi a new Dam was started (see para. 17) instead of repairing the existing breached Dam.

10. In the subsequent rains, the Genji Dam, I regret to say, failed during a very heavy storm (see para. 13), and in consequence two of the smaller tanks which were repaired below in the same Catchment also breached, but the remaining sixteen have all proved that, now they are repaired, they are of value ; and from the further inspection of the State now made, I feel sure that if every tank was put in order the benefit to the State would be great, and strongly recommend that this be carried out as soon as possible, a certain number being restored each year till all are completed.

**Repairs to
all Tanks
recom-
mended.**

11. There are 134 breached tanks in the State, and in consequence all the land in their beds and commanded below is at present lying idle, or only a portion cultivated in the Kharif.

With the tanks repaired all this land would become irrigated land, and with the new Revenue Settlement in force, when the present fixed village assessment will no longer exist, but all cultivated land will be measured, all additional land means additional revenue bringing a profit to the State, and also helping to increase the prosperity of the cultivators themselves, thereby giving them greater power to resist a year of scarcity when it again occurs.

12. During the present tour Surveys have been ordered for the following seven tanks which are lying breached, and Estimates and Plans will be submitted later for the work considered necessary on each to restore and improve them :—

**Surveys
now
ordered.**

Genji, Pagara, Salei, Wasi, Kantri, Pojpur, and Piplasa.

13. The work carried out on the Dam of the Genji tank during 1901 consisted of:—

**Genji
Tank.**

- (1) Re-alignment of earthen Dam, which was raised and strengthened, the section being 12 ft. top width, with front slope 3 to 1 pitched to flood level, and rear slope 2 to 1.
- (2) Across the breach a masonry face-wall 140 ft. long, backed with earth, was constructed, with wing walls in front and a core-wall 30 ft. long at either end, taken into the earthen Dam ; a sluice well and sluice drain under the rear slope being also built near the wing-wall on left bank of nullah.

- (3) A small earthen Dam, across a gap in the low hills to the north, was also constructed to prevent the water passing out into the village tank below.
- (4) A masonry Weir 200 ft. long was constructed with crest 6 ft. below top of Dam at the north end, the waste water to overflow into the village tank below, the weir of which was to be lengthened, and from it the water would find its way back into the nullah below.

This was one of the tanks recommended for repairs by the Assistant Resident (see para. 8), and though a large work, as Genji is situated in the centre of some of the largest Bhil Pals (Site No. 1), it was in consequence opened as a Relief Work; and at one time in the hot weather of 1902 as many as 2,000 Bhil labourers were employed on it.

In the following rains, when the tank had already stored 16 ft. of water, a very heavy storm occurred, 5 inches of rain being registered at Dungarpur during the 12 hours, bringing down a heavy flood, and the Dam breached. It is not easy to say exactly the cause of the breach as it occurred at night, and no one was actually present at the time; but from inspection, the water apparently, on the right bank, found its way round below the wing-wall, and then round the core-wall, carrying away the earthen Dam behind, the wing-wall and core-wall falling when the earth was removed, and being carried away too.

On the left bank the water apparently got under the foundations of the core-wall, forced its way through the earth behind, a portion of the wing-wall and core-wall also giving way as the earth was washed away from behind. The water must have got down to the foundations of the core-wall, either through a hole in the bank or the earth between the wall and old embankment was not properly filled in, and water got in from above.

The foundations do not appear to have been throughout countersunk into the rock, and the masonry above the foundations is inferior. The earth in the Dam appears also to be unreliable, as deep holes occur at intervals, and the villagers report that at one place on the left bank muddy water leaked through and issued along the toe of the rear slope.

Overseer Burkat-ulla Khan, who was in charge of the State Public Works Department at the time, reports that the masonry was green, having been finished only a week before the first flood, and that the earthwork behind the face wall was not completed, as the labourers went off to their homes directly the first rain fell. The villagers also report that trunks of trees and logs were washed down by the flood on the day the Dam breached, and battered against the face-wall and wings; if this was the case, and the masonry was, as reported, green, the wings might have given way, and the water topped them and got behind them in this way.

The face-wall with sluice well and wings at each end, as designed, was adopted to save earthwork—earth being limited—and expense.

The Consulting Engineer for Irrigation inspected the Dam, and his Note on the failure, and recommendations for the work to be done to restore the Dam, are attached in Appendix D. Orders have been given for the necessary surveys to enable an Estimate and Plans to be prepared in accordance with his directions. A large sum of money—about Rs. 20,000—was spent on the work as a Relief work, and in ordinary times it probably would not have been undertaken, and certainly would not have cost this amount. The Dam should certainly be repaired, so that some small return may be obtained for the expenditure incurred, and though the land below is limited, this objection applies to most of the tanks in this hilly portion of the State; the greater part of this land is at present only used for the Kharif, and the bed of the tank, a large area at present waste land, would all come under cultivation. R_{22, 257}.

14. There are two breached tanks on two branches of the same nullah, belonging to the Thakur of Hattai, at Pagara and Salei (Sites Nos. 2 and 3). The Consulting Engineer for Irrigation inspected both, and considered it would certainly be advisable and profitable to repair them, as there is plenty of land below for irrigation, and in the beds for cultivation (See Appendix C). Surveys will therefore be prepared accordingly.

Pagara
and Salei
Tanks.

There will, no doubt, be difficulty in arranging by whom and how the repairs of tanks in Jagir land should be executed, and should the owner be incapable of doing so, what share or future control the Dnrbar should receive if the work is carried out by them; but it is trusted that this difficulty will be got over, and useful tanks in Jagir land, which are out of repair, not allowed to remain idle and of no value; and this point might perhaps be considered in the present settlement.

15. The Pagara Dam is an old one, with a masonry face-wall backed with earth, breached for 200 ft. in length, where the nullah is crossed (Site No. 2). There is rock in the nullah bed, and a masonry core-wall should be built with foundations countersunk into this with earth in front and rear, the wall to be continued well into the old Dam, say for 50 ft. on either side.

Pagara
Tank.

A weir will also be required at the east end, where there is a very good rocky site; and on the west the Dam will be extended across a gap, to prevent the flood water passing down this side, as it used to formerly.

A sluice will also be required, and irrigation channels surveyed to command the land below, and a large area of land in the bed would also be cultivated as the water recedes.

The catchment area of the tank is about $13\frac{1}{2}$ square miles, so allowing 10 per cent. of the average rainfall of 25 inches, we should have 79 m. c. ft. of water available for storage, enough for 790 acres.

16. At Salei the Dam is an earthen one, breached for 100 ft. in the centre, where it crosses the nullah (Site No. 3).

In the bed and on the right bank there is good rock, and a masonry weir should be built here till the high ground is reached, and extended

as a core-wall into the earthen dam on the left bank, the earthwork being strengthened and brought to proper section. The tank has a catchment of $2\frac{3}{4}$ square miles and should be made capable of storing 16 m. c. ft., sufficient for 160 acres, in addition to the land irrigated from the Pagara Tank, as both practically command the same land.

Wasi. 17. At Wasi an earthen dam was commenced in the Famine, but is still incomplete, as a gap of about 50 ft. was left at the north end to allow the flood water of the nullah to pass.

The tank has a hilly catchment of about 3 square miles. The site is a good one, just below the junction of two nullahs and between low hills (Site No. 4), there is a good basin, and good "Dhameny" earth, the best for dam construction. The nullah has very low banks, and the water in the rains evidently spills over the fields below.

This dam should certainly be completed, only earth-work is required, with a weir at the north end, against and partly cut out of the rocky hill; and a sluice should also be constructed near the wing-wall dividing the weir and earthen dam.

The tank should have a capacity of $17\frac{1}{2}$ m.e.ft., the amount of water which can certainly be calculated on as available for storage, and this will be sufficient to irrigate 175 acres. About $1\frac{1}{2}$ miles below this site there is an old breached earthen dam on the same nullah, but the site is not a good one, and the tank proposed above, when completed, will be sufficient for the land available up to the gorge, still further down, through which the nullah flows, and where there is another breached dam near the temple of Mataji (Site No. 5.)

This is a very old dam, with masonry front wall and earth behind, and as there is a stretch of good land below, which could profitably be irrigated from it, its repair is recommended. This tank has a catchment of 1 square mile of its own, besides storing any surplus water that passed over the weir of the new Wasi Tank.

Kantri. 18. Kantri village is at the head of the valley north-east of Pojpur, and two nullahs join in the hills above, and pass out into the plain just above the village.

There is a Dam below the junction of these nullahs, close to the village, but this is breached, and about $1\frac{1}{2}$ miles further up another Dam has been constructed across the main nullah forming the "Nawa Talao" (Site No. 6), a very fine tank, picturesquely situated in the hills.

The Dam has a dry stone face-wall, with earth behind; but there is no proper weir, the water escaping over a rocky ledge at the north-east end, and each year after the heavy floods have passed, a dry stone-wall is built up with earth in front, to raise the water level.

The water for Irrigation passes through an outlet well with wooden plugs into the nullah, and along it to the land below the hills by Kantri. The site is a good one, and the Nawa Talao has a very good basin. The

Dam should be raised and strengthened to store all the water that can be calculated on as available from the 8 sq. miles of hilly unintercepted catchment, or about 106 m. c. ft., sufficient to irrigate 1,000 acres, as the whole valley below down to Pojpur, all good land, is commanded.

A masonry weir of proper length and sluices are also required.

This was approved by the Consulting Engineer, and surveys will be made and Plans and Estimates prepared (See Appendix B). On the branch nullah about 1 mile above the breached Dam referred to above, there is another breached Dam called "Pataliawala" (Site 7), and above this again, another mile further up, another Dam also breached.

The Pataliawala Dam might be repaired with advantage for bed cultivation, and surveys for this will also be prepared.

19. The Kantri Nullah is joined 4 miles lower down by another large nullah from the south-west, and just below their junction is the fine old Bund of Pojpur (Site No. 8), with handsome masonry face-wall of cut-stone steps, and earthen dam, 60 ft wide at top, behind. The dam is 1,000 ft. long, but breached many years ago at the north end, where it joined a rocky hill, and the water has gradually formed a channel behind the rear slope of the dam, which is cut away for some distance. R. Pojpur.

Surveys for the repairs of this dam were made in 1901, but the line for the weir and wing-wall then proposed have been altered by the Consulting Engineer, and fresh Plans and Estimates will now be prepared in accordance with the directions given by him on the spot, and which are clearly noted in Appendix A. A portion of the masonry face-wall at the breached end will be dismantled, and rebuilt for 85 ft. in length at an angle to the present face-wall, following a line of solid rock which extends to the hill beyond, and on this rock, and cut out of this hill, a weir of required length will be constructed.

The masonry wing-wall will be at right angles to the new face-wall and weir, forcing the flood water into a new direction away from the rear slope of the dam, from which a groin of boulders will be run out to complete the diversion of the flood water into a new channel. The Pojpur Tank, deducting the catchment that it is proposed to intercept at Khantri, will have a catchment area of 26 square miles, and of this the tank at Mowai above intercepts about 12 square miles. The Mowai Tank will be surveyed to ascertain its actual capacity and the weir level of Pojpur fixed to give the capacity required to store all the water available from the whole catchment, less that stored by the Mowai Tank.

The Pojpur Tank has a fine basin, all of which will be cultivated as the water recedes; and besides irrigating land below it is anticipated that by its repair the water level in the wells on the nullah banks below will be greatly benefitted.

20. At Pachlasi there is a breached bund (Site No. 9) which the Pachlasi villagers are anxious to have repaired, as there is a large area of land below, with a number of wells, but the water level in these has fallen

considerably, and in consequence a great portion of the land is uncultivated. The Dam starts from a hill at the east end on the left-bank of the nullah, is 1400 ft. long, joining high ground at the west end where the breach occurred.

The original course of the nullah was from north to south along the foot of the hill at the east end of the Dam, but now turns along the toe of the front slope through the breach, and then back again along the toe of the rear slope, until it rejoins its old channel.

The ground is a good deal broken along the front of the Dam, and no earthen Dam of the inferior earth available would be safe without a core-wall; it would, therefore, be better to construct a new Dam altogether on a new line just above the present one, starting from the same hill on the left bank across to a low rocky mound at the foot of the high ground at the west end, the weir being placed on the other side of this mound, and between it and another similar hillock.

The tank has a catchment of only 2 square miles, and the most that can be expected as available for storage with the light soil is 11 m.c.ft. of water, sufficient for 110 acres; but the tank, if constructed, would no doubt benefit the wells below and raise the water level in them, and should be constructed.

Behana
Tank and
Naia Talao
at Ghatod.

21. In addition to these nine, a large number of other breached tanks were inspected, and amongst them a small dam at Behana (near Nolsam) might be restored with advantage, as there is good land below; and at the other end of the State, near Ghatod, there is a fine site for a tank where a long earthen dam lies breached. The tank is called the Naia Talao, but I was informed that the land in the bed and just below the dam is unfit for cultivation; but further down the nullah there appeared to be excellent land, which could be irrigated from the tank, and if this proves correct, the dam should certainly be repaired.

Inspection of all
Tanks and
preparation of
Estimates
by State
Overseer
recommended.

22. In fact, wherever one goes one comes across small breached dams, and the State Overseer could not be better employed than in visiting every tank in the State, making a complete list of them, and estimating for their repairs. If this was done, even if the repairs were not carried out before, when the next famine occurred there would be a small work ready for nearly every village in the State, and work in which labourers would be interested as benefitting themselves.

If the State Overseer has not the time for this, it would be well to engage a special Overseer, experienced in tanks, for this work. The failure in the tanks is generally due to—

- (a) Want of a Weir of sufficient length;
- (b) The earthen Dam not being sufficiently high above existing weir.

To carry out the necessary alterations, to rectify these defects, is simple; and it would also be advisable to provide some simple masonry

sluice, with holes which can be closed either by wooden plugs or by slab shutters working in cut stone grooves, so that the supply of water can be controlled.

At present, in most cases, a deep cut is made through the rock where the weir is fixed, and this is filled up with earth until water is required for Irrigation, when the earth is removed and the water is allowed to run night and day till the tank is dry.

23. In the report submitted to the Irrigation Commission, three Projects for new works were proposed, viz., at Thana, Dholpur and Obri:—

New Works.

24. At Dholpur (Site No. 10), during the 1901 scarcity, materials were collected for the Dam to give relief work to the Bhils in that neighbourhood of the State, and an Estimate and Plans prepared. There is very little land below, and it is not anticipated that any profit to the State would accrue from the execution of the work, which can be postponed till another Famine occurs, and work for the Bhils is again required in this part of the State.

Dholpur Project.

25. The site for the proposed Dam at Thana (Site No. 11) was shown to the Consulting Engineer. This project was surveyed and plans for a masonry Dam prepared in 1902, but this design, with weir 450 ft. long in the centre, is unsuitable, as pointed out by the Consulting Engineer. If the Dam is constructed, the weir should be on the right bank, cut out of the rocky hill on that side, as far as possible with wing-walls to prevent the flood water cutting the rear slope of the dam, which would have a masonry core-wall throughout its length with earth in front and rear.

Thana Project.

The core-wall must be founded on rock for certainly 100 ft. from the weir, and from the hill on the left bank, at the end of the dam; and for the centre 250 ft.—the dam is only 900 ft. long,—if rock is not found, the foundations need only be taken down to half depth of water against the dam. (See Note by the Consulting Engineer, Appendix E).

There is very good earth for the dam, also stone for masonry. The site is a good one and the basin is also good, and very little cultivated land will be submerged.

The catchment area, which is all hilly, is 30 square miles, and allowing 15 per cent. of the average rainfall as available for storage, the tank should have a capacity of 265 m.c.ft.

The objection to the Project is that the valley below is, in normal years, irrigated by water raised from the nullah bed by odhis,—it is the one long stretch of irrigated land in Dungarpur. But there is still a considerable area of land unirrigated, and the surveys now being made will show exactly what amount of that land would be commanded if a tank was constructed.

Instead of a tank the villagers are anxious to construct a weir across the nullah, at a site they pointed out close to the village, from which a canal would be taken; as they say in normal years the nullah

flows up to the end of the Rabi crop irrigation season, and they would be able, by this means, to increase the area of irrigated land and supplement the wells. Surveys will also be made to see how much extra land would be commanded in this way. The site is a good one for a weir, and this proposal might be first carried out, as in any case, if a tank was constructed later, it would probably be better to let the water down the natural nullah—benefitting the odis on the bank on the way—to a weir at the site proposed, and start the low-level canal from this point; and the canals to command the high land, at present unirrigated, would start from the Dam itself.

Obri.

✓ 26. Opposite the village of Obri, the Moran River passes through the hills, and there is a good site for a Storage Reservoir (Site No. 12).

On the left bank there is a high hill with rocky sides, and a ledge of good sound rock all across the river bed, and on the right bank, lower hills helping to form a natural dam.

There is a good basin, and the river has here a catchment of about 150 square miles, so that there is any amount of water available for storage, but the height of the Weir, which would be across the river itself, is limited by the level of the land of the villages of Matwet and Gadda, a large area irrigated by wells, about two miles above the proposed dam.

The site was selected by me in 1901, but surveys were not then carried out; but the Assistant Resident, Mewar, is anxious that some use should be made, if possible, of the Moran River, and suggested a Dam at Daiana (Site No. 13), about $3\frac{1}{2}$ miles below Obri, as from this village down to the Mahi River on the border there is comparatively open land. A weir might be made across the river at Daiana, and another at Patli, $1\frac{1}{2}$ miles above (Site No. 14), from which Irrigation channels could be taken; but the only good site for a Storage Reservoir is the one described above, opposite Obri, and water would be let down from it to the weirs and Irrigation channels below. Surveys have therefore been ordered for this combined project, and if it proves worth working out in detail Plans and Estimates will be submitted in due course.

The Project will be far larger and more expensive than any of the others proposed, and probably beyond the requirements and means of the Dungarpur State for many years to come, but as in the case of Thana, it will be advisable to carry out the weirs, and Irrigation channels from them, first, to take advantage of the natural flow of the river in normal years; and the Obri Storage Reservoir can be constructed later, if irrigation extends and more water is required.

Financial
Difficul-
ties.

27. It will, therefore, be seen that there is plenty of work waiting to be done in Dungarpur to improve and increase irrigation, which would be of value to the State if carried out.

So much of the country consists of hills and waste land that it is especially important to make full use of every bit of culturable land, and this can best be done by restoring all the tanks, bringing as much of this as possible under irrigation. By restoring the tanks the water level in the wells should also be raised.

That this was realised originally is shown by the number of tanks in the State, so many of which are now lying breached and out of repair.

But as in Banswara and Partabgarh, which are under the same Political control as Dungarpur, the same financial difficulties stand in the way of its execution.

This has been referred to more fully in paras. 23, 24, 25 of the Report on the Banswara State, and the same remarks apply to the present case.

Dungarpur is over 3 laes of rupees in debt, and any sum that could be set apart annually from the Revenue for this purpose would in consequence be small compared with what is required; so that unless Government assistance can be obtained, it will take years to carry out what is proposed.

December 1904.

F. ST.-G. MANNERS SMITH,
SUPERINTENDING ENGINEER,
Protective Irrigation Works, Rajputana.

**Note by the Consulting Engineer for Irrigation, Rajputana,
on the Dungarpur State.**

**Tour of
Inspection.**

I entered the Dungarpur State on the 5th December 1904, and have marched about 100 miles through the State with the Superintending Engineer (Mr. Manners Smith), and with the exception of Obri and Pachlasa, which owing to my being down with fever I was unable to see, I have visited every important place, I think, with him. This has enabled us to discuss and settle matters together at each place and so to save time; for these States are difficult to reach.

Results.

2. The time at our disposal has been too short to enable us to see every place, but we have seen enough to form a good idea of the country, and of the best course we think should be adopted to suit local conditions.

Mr. Manners Smith has given detailed instructions in writing to the Overseers, who accompanied us, and has explained all to them at each place; they will be able now to make the necessary surveys, and the Plans and Estimates for the Projects proposed will be prepared and submitted in due course.

Suggestions limited by Local Conditions.

3. When one sees the value of water, and the difference Irrigation makes, one would like to bund up every stream, and make a reservoir in every depression; but one soon finds what difficulties there are in the way of doing anything of this sort, and the necessity of adapting one's recommendations to local conditions.

Difficulties to contend with.

4. Mr. Manners Smith has described so fully the physical characteristics of the State in his Report, that it is unnecessary to repeat them here, or to do more than allude to the main conditions we have to contend with, which briefly are:—

- (1) The Revenue of the State is under a lac of rupees (para. 6).
The debt of the State is now about Rs. 3,10,000, which sum is due to the Imperial Government, which has taken over this debt solely to help the State.
- (2) Nearly all the Sirdars and Talukdars are said to be deplorably embarrassed, and the cultivators to be generally in debt.
- (3) The hilly nature of the country and the depth of the large rivers prevent the possibility of any large canal scheme, and compel one to fall back upon small points; which are all the more necessary from the small areas among these hilly tracks which are available for cultivation. While the hamlets, as a rule, are so far apart, and the population so sparse that any large project in one place, even if it was possible to carry it out, could not be taken full advantage of, and would be unlikely to pay a fair return on the outlay.

(4) The soil is so good and retentive that in years of normal rainfall irrigation is not necessary. It is only when the rains fail that the difficulty about water occurs.

(5) The sad mortality during the last Famine (see para. 5 of the Superintending Engineer's Report) shows the need of help and the difficulty of dealing with a population so scattered and so helpless as the Bhils.

5. At the same time one sees small tanks everywhere. There are no less than 340, of which 206 are said to be in use; but 134 are in need of repairs, showing how the people in former days recognised the value of storing water, and the suitability of tanks to the country. Nineteen of these were repaired in the last Famine. I think it is impossible to spend money in a better way than in putting the existing tanks in a proper state of repair. It was a cheering sight to see the green oasis, wherever water had been stored, in the bright cultivated area below, or the cultivated area in the bed of a tank; sometimes both, within and below. It must naturally give greater power to assist in a year of scarcity, when it again occurs. Tanks.

The repairs of existing tanks I consider the most necessary work in the State. How these tanks are to be all repaired without funds or some special provision for such work, seems quite impossible.

6. Such Irrigation as exists is carried on from tanks and from wells and from pools in nullahs. Irrigation at present in good years not necessary.

Unfortunately when the rains fail the tanks are often dry, and there is a deficiency in the wells and nullahs. The soil is so retentive that in years of ordinary rainfall sugar-cane and rice even are often grown in the flat depressions between the hills, and mature without further watering; sometimes grain is also sown afterwards. In fact, in ordinary years irrigation is not necessary, although water wherever it can be stored does good.

The areas cultivated are not known at present, but as a settlement is in progress these matters will soon be on a proper footing.

7. Regarding wells, there are said to be 2,500, of which about 800 are said to be in disuse for want of repairs; but the Authorities seem to be alive to the value of wells, for a sum of Rs. 10,000 has, I understand, been set apart for *taccari* (advances) to cultivators, and 105 wells are being now deepened and repaired. Wells.

Owing to the scanty rainfall during the past few years the level of the water below ground has fallen considerably everywhere; now, therefore, is the time to deepen wells, and money cannot be spent in a better way. Every well in the country that needs deepening or repair ought to be attended to without delay.

Projects
noted.

8. Attached are my Inspection Notes on the following projects :—

Pojpur	...	Old native Bund.
Genji	...	Tank breached.
Thana	...	New Project.
Kantri	...	do
Pagara	...	Old native Bund.
Salei		do.

Recom-
menda-
tions
regarding
Tanks.

9. I fully endorse the recommendations made by the Superintending Engineer (Mr. Manners Smith), and especially in paras 10, 11, and 22 of his Report.

The Plans and Estimates, which will be prepared under his supervision, will be printed, and submitted in due course for record, and the works, if properly carried out, ought, I think, to be of benefit to the State. If our investigations help to inspire an interest in Irrigation, our efforts will not have been in vain.

Acknow-
ledge-
ment for
help
received
on Tour.

10. I cannot close the Note without expressing our acknowledgment to Mr. Holme, C.S., in Political charge of Partabgarh, Banswara and Dungarpur, for the great help we have received from him in our tour of Investigation in these States. Our thanks are due, not only to him, but to the Kamdars also of each State—Lala Munna Lall, of Partabgarh; Rao Sahib S. R. Gupta, of Banswara; and Rawat Ganesh Ram, of Dungarpur. Each went with us through their respective States, and did their best to help us. And if only funds can be provided, I am confident they will do what is possible, and there will be some hope for the future.

Tanks in
Jagir
Lands.

11. With reference to tanks in lands belonging to Jagirdars, it should be explained to them that it is a duty they owe to the State, and that it is to their own interest to make these efficient; that the only object in view is to promote their own welfare, and every assistance should be afforded them to carry out such work.

If they are sensible they will see this, for too often it is more from want of means that they fail to do anything.

Every consideration should be paid to their rights, and if this policy is carried out with tact, and in this spirit, I think it will be successful.

If any money is advanced to them, as soon as it has all been refunded the Tank should be made over to them absolutely, and no interference be allowed. One good example of this sort will inspire more confidence all round than anything else.

Sugges-
tions

12. Briefly the suggestions made are as follows :—

- (1) The urgent need there is of some special grant being made solely for Irrigation. There is no hope of any real good arising from our recommendations unless a bold and liberal policy is adopted, combined with a hearty and steadfast interest in the subject from all in authority in the State.

- (2) Arrangements for proper supervision must then be made to ensure work being energetically and properly carried out. A good native Engineer should, I think, be appointed to look after the three small States of Partabgarh, Banskara and Dungarpur, with a good Overseer under him in each State.
- (3) All Tanks that are in need of repair should be taken in hand at once, and put in a thoroughly efficient state. A statement of all the tanks should be prepared, with a number to each, and a return be submitted annually, showing the condition it is in, the expenditure, if any, incurred during the past year, the total up to date, the areas irrigated from it by flow or lift, and the approximate value of the crops irrigated. In this way the value of each tank would be seen.
- (4) Similarly with wells, so that any that need deepening or repairs may be taken in hand without delay. It is impossible to overstate the good influence wells in the bed of tanks, or below, have on the land round them, and when the rains fail or the beds of tanks go dry.
- (5) Enquiry to be made by the local authorities whether there are any places on nullahs where weirs of any kind can be made to assist the supply of water to wells, or "Odis" (half open wells) such as suggested near Thana (see Superintending Engineer's Report, para. 25 and my Inspection Note, Appendix E). If so, the native Engineer to be directed to prepare Estimates.

S. S. JACOB, Col.,
*Consulting Engineer for Irrigation,
 Rajputana.*

December 1904.

APPENDIX A.

Note by the Consulting Engineer.

Pojjpur.—Old broken Bund.

On the 10th and 11th December 1904 I inspected the old broken Bund at Pojjpur with Mr. Manners Smith, Superintending Engineer. The portion that exists is about 800 ft. long, and is a good specimen of an old native bund, an earthen dam about 60 ft. thick, faced with cut stone steps on the inner side.

The breached portion is at the north end. There is a gap of about 400 ft. long between the old Bund and the black rocky hill opposite. How this was originally filled up it is now difficult to say; all now visible are the remains of a low brick masonry wall in a few places, which they say was built afterwards to hold up a little water, and was soon carried away.

The whole force of the flood from a Catchment of about 38 sq. miles pours over the rocks here, and has scoured the place out, and further on threatens the rear slope of the Bund.

There is a narrow cut made through the rock in a saddle south of the village, and close to it, about 200 ft. long, average 25 ft. deep, and 10 ft. wide, which, people say, was intended as an escape, and as a cut by which water could be baled out from the reservoir to the fields below.

A Project was, it appears, prepared in the last Famine for repairing this work, making the escape in a line with the bund on the rock at the north end, and it was with reference to this that my opinion was desired.

I do not think the weir can be safely made as then proposed; the rock in a line with the bund at the north end is laminated and shaley, of poor quality, and all the laminations slope outward and downwards so that there would be danger of water with any head forcing its way through the rock and under any superstructure.

I suggest advantage being taken of a natural spur on the north-west which approaches the north end of the broken dam, and to cut into this rocky hill as much as may be required to form a proper weir, and to connect it with the old bund at a point about 50 ft. from the broken end by a masonry dam let well into the rock, as there is good sound rock here.

This masonry wall would have to be taken well into the old Bund, and the connection be well made to prevent any outflanking by the water.

The advantages of this line are that there is less work, as it saves building up so much and it is far removed from the shaley edge of rock near the old weir.

The north end of the old bund will have to be removed for 20 or 30 ft., and a guide wall of masonry built from a point about 85 ft. distant from the old bund, in the direction of the escape, to a ledge of rock in a

north-east direction, to keep any overflow from the north end of the old bund. A spur will also be necessary between two rocks about 150 ft. lower down to keep the overflow away from the toe of the rear slope of the old earthen bund.

An outlet sluice for Irrigation can be built in the masonry portion of the escape. The cut stones of the inner face of the old bund will require to be cleared of all shrubs and grass, and the crevices filled in and re-pointed.

The basin is magnificent, and as the water recedes a good deal of land might be cultivated, and there is good land also below.

The Superintending Engineer has ordered Plans and Estimates to be prepared in accordance with these suggestions, and I hope the Durbar will be able to carry out the work and restore this fine old bund. Until this is done, the existing broken bund is lying useless, and every year water which might be of great benefit flows away and is lost to the country.

APPENDIX B.

Note by the Consulting Engineer on the Kantri Storage Project.

On the 11th December the Superintending Engineer (Mr. Manners Smith) took me to see a site where he thinks something might be done, about a mile north of the village of Kantri, at the head of a fertile valley, north-east of Pojpur. Two nullahs unite near here, and a small earthen bund exists, breached at the west end, where the floods pass over good sound rock. The width of the gap is only 400 ft., but owing to the contracted basin, and an existing tank above, a good reservoir could not well be made here.

We examined the east nullah and found the remains of a small broken earthen bund, not worth repairing, except perhaps for bed cultivation. We then ascended on to high ground, and had a good view of the basin and of the west nullah which is bunded up already about half a mile higher up with a good substantial earthen bund, with a dry stone face-wall. There is an escape over rock at the north-east end; this appears to be closed every year temporarily with stones and mud. If the dam is not raised, this requires a good masonry wall with sluice boards sliding in vertical cut stone grooves.

A picturesque tarn, called "Nawa Talao," is formed by this bund. Water is still standing, and a little Irrigation in the nullah bed is being done from an outlet well with wooden plugs. The basin for storage is good, but the capacity is limited; the water often overflows.

This dam should be raised so as to store all the water available from the hilly catchment of about 8 square miles, as there is plenty of good land below, and round Sandiawara, which is at present unirrigated. The height of the Dam will depend upon the result of surveys and levels, which the Superintending Engineer has ordered to be made.

If this Reservoir is made, and the Pojpur old bund is restored, it ought to be of great benefit to the country.

APPENDIX C.

Note by the Consulting Engineer on the broken Bund at Pagara and Salei.

On the 13th December 1904 inspected the remains of a broken bund at a hamlet called Pagara, about 2 miles west of Pharoj, and 10 miles east of Dungarpur.

The nullah which comes from Khora Kachwasa passes this place, and the remains of the bund here show a substantial earthen bund faced with stone on both sides of the nullah, with rock at each end for the escape. The gap in the centre is about 200 ft. wide through which all the water of about $13\frac{1}{2}$ square miles now passes.

There is rock in the bed and a large block of masonry, the foundation of a small temple which once stood on the bund. It is difficult now to say what was the cause of the breach, probably the escapes were far too small. The basin is a good one. Judging from what we could see from the top of a hill below the bund, there is land below which can be irrigated, but to what extent it is difficult to say until levels have been taken.

This bund ought certainly to be repaired with a masonry core-wall let into the rock taken right across the gap, and well into the old bund at each end.

It may be possible to let water down the nullah and by putting one or more low masonry weirs across it founded on rock, to raise the water to the levels of the fields at either sides, or to allow it to be used by lift.

There is another nullah which comes from the west and joins the main nullah just below the broken bund alluded to above. There is a small broken earthen bund on this about half a mile up stream near the hamlet of Salei. The gap is about 150 ft. wide. There is rock in the bed. This might be repaired by a small masonry dam in this gap, which would also serve as the escape, with a face-wall from it to the rock on the right, and a core-wall into the old bund on the left bank, unless a natural escape can be made over the rock at the right or south end. It is a small work. If these two bunds can be restored, they ought to do good.

APPENDIX D.

Note by the Consulting Engineer on the Genji Project.

I inspected this work on the 14th December 1904 with Mr. Manners Smith, Superintending Engineer, Protective Irrigation Works.

This work was started in the Famine of 1901-02, mainly to provide work for the Bhil population around. At one time 2,200 found employment here.

The work consisted of a masonry face-wall in the centre portion, 140 ft. long, with a core-wall at each end 30 ft. long; where the core-walls joined the face-wall masonry wings were provided to support the earth of the inner slope.

The water has breached the bund at each end of the wall, and has made a gap 90 ft. wide at the south end, and about 30 ft. wide at the north end.

The core-wall at the north end is partly broken down, and at the south end has completely disappeared, leaving only the foundation of the wing wall. There are several holes in the earthwork; how far these extend into the body of the bund it is difficult to say without opening it out.

Water is said to have come up from under the bund at a point about half way between the sluice-wall in the face-wall and the north end of the bund, and to have come up discoloured, not clear, showing that mischief was going on.

The reduced level of the top of the Dam was	...	132
" " " Flood level	... ..	129
" " " Weir	... ..	126
" " " Bed of Nullah...	... ..	100

The masonry in parts of the remaining walls, near the top, is not good, and is cracked in places.

It is said the bund breached about 10 p.m. at night after a very heavy fall of rain. As no one saw what actually occurred, it is difficult to be sure what happened.

Overseer Barkat Ullah Khan, in his letter dated 12th April 1903, states:—(1) The masonry was not dry; (2) That the earthwork behind the face-wall was not completed owing to the workpeople leaving for their homes when the first rain fell; (3) The top portions of the wing-walls and core-walls being only $1\frac{1}{2}$ ft. thick were, he thinks, not strong enough to oppose the force of a sudden rush of water.

If there was not sufficient earth behind they naturally would not be strong enough to stand alone.

(4) The rainfall is said to have been 5 inches in an hour, probably this is not quite correct, but there is no doubt there was a sudden rise of water, and the earthwork and masonry had to meet it all at once, instead of gradually. Dead trees are also said to have been brought down with the flood, and to have battered the walls.

At the south end wing-wall the water probably percolated in a straight line along the inner side of the wing-wall until it reached the core-wall, and then seems to have passed under it and round the south end. There is no cohesion between the earth and the masonry, and nothing to prevent this having occurred.

Whether the masonry walls were overthrown at the top from any of the causes noted above, there is no doubt the water got somehow behind the masonry, and washed away the earth at the back; nothing could then save the bund. Not a vestige of the south core-wall remains; merely the rocky surface below where it stood; it is not certain even if it rested on this. The material in front of where the south core-wall stood is earth and stones mixed, and is not good enough.

At the north end the trench originally cut to receive the core-wall does not seem to have been properly filled in, and although no water apparently got round this end, it appears as if water had passed under part of the wall.

Under these circumstances what should be done to restore the work? I think the earth alone is not to be trusted, and would suggest:—

- (1) The present face-wall should be treated as a core-wall, and be covered up in front with good earth to flood level R. L. 129, leaving a horizontal "terre plein" 6 ft. wide at the top, the inner slope being 3 to 1 as usual.
- (2) The broken parts of the masonry to be removed and re-built.
- (3) The debris in front and behind the former core-walls to be removed, fresh masonry core-walls to be built; at the south end well bedded into the rock, and where the rock ends to be carried 5 ft. lower, and well into the existing bund.
- (4) Good earth, free from stones, to be placed on both sides, and rammed well against the wall, the surface of which should be left rough.
- (5) As it is evident the earth here is not to be trusted, a masonry core-wall should, I think, be put along the whole length of the bund, and be taken down everywhere at least 3 ft. below ground. To avoid the depth which it would be necessary to excavate if the wall is put now in the centre of the bund, it might now be put where H. W. L. 126 cuts the inner slope, and be carried up 3 ft. higher, show-

ing above H. W. L. as a face-wall; the earthen bund above it being sloped back 3 to 1 as at present.

- (6) For the outlet Sluice a small culvert might be made along the north wing-wall, so as to utilize some of the existing wall. The channel to be covered for a length of about 50 ft. arched over. At the end where it would join the present outlet well an open chamber might be made by cross-walls, and an iron sluice valve be fitted in the wall dividing the chamber from the sluice-well, which would admit water to the outlet well as desired. The sluice-well would have to be partly broken down and re-built, and the round holes in it closed up and buried under the earthwork of the inner slope.
- (7) The proposed new core-wall should be connected with the old core-walls, so as to form an impervious and continuous masonry wall throughout the entire length of the bund.

To do this now, as proposed, will cost very little more than it would have cost if made in the first instance. The necessity for it was not perhaps then apparent. Now I think it is. From what has occurred it is evident the earthwork is not to be trusted, and until a masonry core-wall is carried along the whole bund I do not think it can be considered safe.

To leave the bund as it is will be a blot upon the country; and no return can be expected on all the expenditure which has been incurred, until it is completed. The Superintending Engineer has ordered an Estimate to be prepared for completing the work as suggested above, and I hope the Durbar will be able to have the work carried out.

APPENDIX E.

Note by the Consulting Engineer on the Thana Project.

On the 15th December 1904 I went with the Superintending Engineer (Mr. Manners Smith) to inspect the Site for the Storage Reservoir at Thana, about 6 miles west of Dungarpur.

The Kamdar of Dungarpur, Rawat Ganesh Ram, came with us and took us first to see the site for a weir, which he thinks might be useful if placed across the nullah on the east side of the village of Thana and close to it, to irrigate land on the banks lower down, utilizing the flow which is said to continue for some time after the rains in normal years.

The site is an admirable one. The natural ledge of rock, after the rains, forms now a deep pool for about half a mile above it, from which water is drawn by Persian wheels on both banks, to irrigate fields adjacent.

This year (1904) owing to deficient rainfall the pool was dry, but the wells had water and the crops were in good condition.

It will be advisable to have the weir provided with sluices to allow of free water-way in flood, as the banks are low here, and if floods are not allowed a free course in the nullah, or are not confined by wings, they may top the banks and do damage.

It is not known what land can be irrigated from a weir at this place, and its success will depend upon this, but the Superintending Engineer has arranged to have levels taken, and a Project drawn up.

We then went about half a mile up stream until we came to the site where it has been proposed to make a Storage Reservoir, and Plans were prepared for this about 18 months ago.

The site is an excellent one. There is rock at both sides, and although there are fissures in the rock which may allow some leakage, if leakage does occur it will not be lost, but will be caught by the proposed weir alluded to above. This gorge is about 700 ft. wide.

The basin is a fair size, and all the drainage of about 32 square miles from hilly ground passes by this nullah, which flows under the left or west bank, and then across to the east side. The soil here is very good for an earthen bund.

The proposal was to have a masonry dam here, and to allow the surplus water to pass over it in the centre.

I do not think this is advisable, because the water would have to fall about 50 ft. ; it is uncertain what depth rock is found, and it would cut up the ground below.

I would advise a good earthen bund, with a masonry core-wall for about 150 ft. at each end to prevent percolation along the hillsides. This core-wall should be let well into the hillside, and where possible be founded on rock, or if rock is not met with, taken down to a depth equal to half the depth of water against it. If rock is found to exist at a reasonable depth, it would be as well in this case to put the core-wall right across upon it.

The escape to be on the hillside on the east or right bank : the hill to be cut into as much as may be required. The material could be used on the work.

A masonry guide-wall will be necessary to prevent the overflow from cutting into the rear slope on its course to rejoin the nullah below.

The nullah passes near the foot of the rocky hill here, and would carry off the flood without allowing it to damage the fields which are here on the left bank.

There is a saddle directly below the hamlet on the north bank ; perhaps it may be possible to make some use of this to take off a portion of the surplus water, but in this case it should be taken so as not to injure the fields below ; if it could be diverted northward through another small saddle, as suggested by the Superintending Engineer, it might perhaps be made some use of beyond. Levels will settle this question.

The advantage of this Storage Reservoir would be, that it would ensure the wheel or pool in the nullah below always remaining full of water even in bad years, and all the wells in this narrow but rich valley being fully supplied. It would also feed the weir and canal which it is proposed to make half a mile lower down.

The combined Project appears to be a very good one, and if it can be properly carried out, ought to be of great benefit to the country.

Until surveys for the canal have been made, and a revised Plan and Estimate prepared, it is not possible to say more. The Superintending Engineer has given instructions to have these carried out.
